

Differential Vulnerability to Climate Related Disasters Among Communities
Along the Santa Cruz Coastal Landscape

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This paper is an analysis of social and environmental vulnerability to the effects of sea-level rise and increased flooding of the Santa Cruz coastal landscape. My research shows that someone's vulnerability to the effects of climate change is not only a factor of their geographic location, but is also influenced and determined by their social status and their property relations within the society. Because of this, socially vulnerable communities are usually placed in geographically vulnerable locations. As climate change continues to change our daily lives and disrupt the global ecosystem, it will continue to put pressure on the already existing social structures as well as exacerbating the social inequalities that are already present within our societies. My analysis shows that there is evidence of existing differential vulnerability to the effects of climate change along the Santa Cruz coast and that we should be taking action now to be able to adapt and cope with these changes in a socially equitable way. Through a comparison of my analysis of vulnerability and the City of Santa Cruz's Climate Adaption Plan, I provide possible mitigation and adaption measure that can be taken to protect the most vulnerable communities within the landscape.

Este documento es un análisis de la vulnerabilidad social y ambiental a los efectos del aumento del nivel del mar y el aumento de las inundaciones del paisaje costero de Santa Cruz. Mi investigación muestra que la vulnerabilidad de alguien a los efectos del cambio climático no es sólo un factor de su ubicación geográfica, sino que también está influenciada y determinada por su estatus social y sus relaciones de propiedad dentro de la Sociedad. Debido a esto, las comunidades socialmente vulnerables generalmente se colocan en lugares geográficamente vulnerables. A medida que el cambio climático siga cambiando nuestra vida cotidiana y perturbando el ecosistema mundial, seguirá presionando las estructuras sociales ya existentes, así como exacerbando las desigualdades sociales que ya están presentes en nuestras sociedades. Mi análisis muestra que hay evidencia de vulnerabilidad diferencial existente a los efectos del cambio climático a lo largo de la costa de Santa Cruz y que deberíamos tomar medidas ahora para poder adaptarnos y hacer frente a estos cambios de una manera socialmente equitativa. A través de una comparación de mi análisis de vulnerabilidad y del Plan de Adaptación Climática de la Ciudad de Santa Cruz, proporciono una posible medida de mitigación y adaptación que se puede tomar para proteger a las comunidades más vulnerables dentro del paisaje.

Keywords: Differential Vulnerability, Resilience, Climate Change, Sea-level Rise, Santa Cruz, Social Vulnerability, Infrastructure, Socio-Ecological Systems

Introduction

This paper is a socio-ecological analysis of the Santa Cruz landscape and how different social and geographic factors influence one's vulnerability to the effects of climate change, primarily sea level rise and increased flooding. Santa Cruz is known in California as a popular beach town but within that landscape there are serious social inequalities that are present and that are responsible for putting socially vulnerable communities in the most geographically vulnerable locations. Through a combination of data collection and fieldwork, I explore the ways that, in Santa Cruz, vulnerability to climate change is produced through a combination of both geographic factors as well as social factors and their property relations within the landscape. Because of this, the coastal communities of Santa Cruz are experiencing contrasting levels of risk and a differential vulnerability within the city's population.

Past research has been done into the topic of vulnerability to natural disasters, but often neglects to include the integration of climate change into the analysis of vulnerability to natural disasters. Similar to the natural disasters that have been experienced in the United States, such as Hurricane Katrina in New Orleans (Bullard and Wright, 2009). I want to know if future climate disasters, which are likely to increase, will have unequal effects on the poor and people of color. I explore how and why some communities are more vulnerable to the effects of climate change compared to other communities in the same geographic area, and what the role of race and socioeconomic status plays in affecting vulnerability to climate change. Understanding the combination of the social and ecological factors that are influencing vulnerability in this landscape will allow me to better understand who will be most vulnerable to future disasters and in what ways.

In this paper I aim to show how race, class, age, and geographical location can affect and influence one's vulnerability to sea level rise and increased flooding of the landscape in Santa Cruz. I use both social and physical factors when addressing vulnerability in an attempt to gain a better and more comprehensive look at vulnerability within the city and different communities. My analysis shows that communities of color and low-income households are more likely to be vulnerable to these ecological changes along the Santa Cruz coast and that the city and federal governance of these changes has historically been partially responsible for the social inequalities that are still present and being exacerbated by the effects of climate change. Through this analysis, there is a clear level of differential vulnerability to climate disasters that has presented itself within the landscape solely based on the factors of race, class, age. This conclusion has serious impacts on how the City of Santa Cruz is adapting and mitigating the effects of climate change to protect their most vulnerable residents. As climate change continues to fuel increased natural and human disasters, the social inequalities within these landscapes, especially coastal landscapes, will continue to shape who is most affected and how.

Scientific Background

Anthropocene Era

Humans have had a significant impact on the natural world and its environment. Over the past decade, our climate has changed at an unprecedented rate that has not been seen before. Leading international climate scientists around the world agree that human activities are the primary contributor to the changing climate. There are many types of greenhouse gases with carbon dioxide (CO₂) being the main contributor to the greenhouse effect. This carbon dioxide is put into the atmosphere through the burning of coal, oil, and even the fuel in our forests. These

dense forests that are being cut down for their wood also act as carbon sinks and, once they are cut down, are no longer able to absorb that carbon in the atmosphere which leads to unnaturally high levels of carbon dioxide in the atmosphere which increases the already present greenhouse effect (IPCC, 2007).

According to some scientists we have arguably thrown ourselves into a new geological era called the “Anthropocene” in which, due to our alterations of atmospheric chemistry, it will be geologically possible to tell when humans were present on the landscape (Steffen, Crutzen, McNeil, 2007). This release of excessive greenhouse gas emissions has caused dramatic and unexpected changes in the global climate as well as regional geography. The Intergovernmental Panel on Climate Change (IPCC) has stated in its 2007 Synthesis Report that: Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. Eleven of the twelve years between 1995-2006 were the warmest in recorded history. One of the biggest impacts on human civilizations will be the increasing sea level rise and flooding of coastal cities due to melting ice and warmer ocean waters. The rapid and unprecedented increase in surface temperature is also accelerating the planet’s water cycle, which will make severe storms and increased coastal flooding (IPCC, 2007).

Climate Change and Natural Disasters

Our rapidly changing climate is expected to have increased effects on the formation and duration of more extreme storms around the world. According to The National Aeronautics and Space Administration (NASA), with increasing global surface temperatures, the possibility of more droughts and increased intensity of storms will likely occur. As more water vapor is

evaporated into the atmosphere it becomes fuel for more powerful storms to develop. More heat in the atmosphere and warmer ocean surface temperatures can lead to increased wind speeds in tropical storms. Rising sea levels expose coastal cities to the force of waves and currents, causing erosion and flooding. As temperatures continue to rise, more and more water vapor could evaporate into the atmosphere. Because of this, it is possible that natural disasters will become more frequent and more extreme, putting coastal populations at increased risk (NASA, 2005).

Research Problem Statement

Study Site

Santa Cruz will be impacted by nearly all of the effects of climate change including changes in the weather, sea-level rise, depletion of fresh water resources, destruction of ecosystems, degradation of human health, disruption of the economy, and erosion of the coastline. Located between the Santa Cruz Mountains and the Monterey Bay, the City of Santa Cruz faces multiple threats from its geographical location as climate change continues to shape our surroundings. As a coastal city with a running river going through its heart, Santa Cruz is exceptionally susceptible to the effects of possible sea level rise as well as flooding of the city due to increased extreme weather events and precipitation. As the river begins to flood, so do the neighborhoods that are located near that river, including the downtown. The rise in sea level could cause increasingly severe coastline destruction and lead to the displacement of homes and businesses in the downtown and other low-lying areas. A rise in groundwater below the city will also cause flooding of underground infrastructure like basements (Santa Cruz Climate Adaption Plan 2017-2022).

Climate change is expected to impact Santa Cruz's weather patterns and will very likely cause more frequent periods of wet days and hot dry days. Santa Cruz will also see more extreme periodic heat waves, more fog in the summer months, and more severe freezes during the winter. The increase in precipitation will not be over long periods of time but rather in short and extreme bursts that will increase the chances of flash flooding and mudslides. These changes in weather and sea level are what I will be focusing on as they are the most likely to be impactful on the Santa Cruz community. The intensity of these disasters has been increasing due to increased anthropogenic impact on the climate and continue to increase in frequency and magnitude.

Socio-Ecological Landscapes

The physical and geographical factors influencing one's vulnerability to these local effects of climate change do not exist without influence from the existing social structures that shape the landscape and the people that live there. In order to gain a more comprehensive understanding of vulnerability I analyze how the social and ecological factors influencing vulnerability came to be in this landscape and how they interact with each other to form a dynamic relationship, creating a unique socio-ecological landscape. Within this landscape there are people experiencing disparate levels of vulnerability to the same geographic threats based on their socio-economic status and relationships to the land within the city. This paper is a study into how this socio-environmental vulnerability is produced in Santa Cruz, why people are facing differential levels of vulnerability and, based on my analysis, what groups will be the most vulnerable to the continued effects of climate change. This information will allow me to gain a better understanding of my initial research question: How is differential vulnerability to climate

disasters shaped within the Santa Cruz landscape and will these climate disasters exacerbate and make worse the already existing social and economic injustice within Santa Cruz?

To conduct this research, I will be using different methods of data collection and ethnographic observations and interviews to come to understand how socio-environmental vulnerability is produced in this landscape and in what forms. I will also be using key informant information and documentary analysis to look at the policies and measures the City of Santa Cruz is currently taking to address this vulnerability, if any. I will compare my analysis of vulnerability with the analysis of the city to see how these differ, and how the city's analysis might be improved on. To help understand the data that I collect, I draw on existing literature to explore existing frameworks and theories, including theories of social vulnerability, resilience and post disaster theory. This research is increasingly important as it adds to the knowledge and evidence that climate change will exacerbate the already existing social inequalities and structures present within the landscape. Although this paper is a case study of the City of Santa Cruz, the general principles and conclusions can be applied to other coastal cities and regions around the world.

Objectives

- Address how Santa Cruz is being affected by CC and how will that impact humans
- Assess how vulnerability is produced and in what ways within this landscape
- Address how that vulnerability will that get worse as climate change progresses
- Understand what the City of Santa Cruz is doing to address this vulnerability

- To come up with solutions and recommendations for socially equitable mitigation and adaption measures for the city.

Literature Review and Theoretical Framework

Vulnerability theory has been heavily influential on my research, theory on social vulnerability and environmental vulnerability. Vulnerability in this research is defined as “the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard” (Wisner and Fordham, 2014). Vulnerability in this definition includes social and political vulnerability that is produced through existing inequalities. Vulnerability must be looked at through a political ecology framework, integrating the social and environmental factors and seeing them as inseparable from one another when forming the overall landscape. Additionally, within this political ecology framework it is increasingly important to focus on the existing power structures and relationships within the landscape that create these social vulnerabilities. Using this framework, the creation of natural disasters can no longer be looked at as just an ecological or physical event, but also must be seen as being influenced and dependent on the social and economic structures and systems within the landscape. These social structures are dependent on the marginalization present within the society as societies allocate access to resources based on factors such as caste, gender, or age; by socioeconomic class or inherited and presumptive “rights” to land, water, and pasture; and by the degree of participation in politics, voice, and the ability to enlist use of political power (Wisner and Fordham, 2014).

The impacts and vulnerability to natural disasters are not only dependent on geographical and physical vulnerability, but also dependent on relationships within a community and the

institutional and political economic structures that are in place. Because of these additional factors, people do not always have the same resources to cope with the effects of climate change and this lack of resources are often based in economic and social factors like race and class. Using a case study of the Egyptian Mubarak Project, Malm and Esmailian (2013) discuss how contrary to popular belief, frontline communities often consist of the wealthy who are able to afford proper infrastructure to adapt to environmental changes and the poor who are not able to adapt and are stuck there. Vulnerability in this context is not as much based-on location or the land that one stands on, but rather based on land relations and power dynamics within the landscape. People who have a low economic status have an accumulated disadvantage to the effects of climate change based on their political economic status. (Malm and Esmailian, 2013). This approach to vulnerability focuses on the economic contributions but fails to attend to the historical and cultural disadvantages that people have in the face of climate change.

A more complex understanding of vulnerability is provided by Kimberley, et al. (2019) and their understanding of differential vulnerability. Vulnerability thus far can be seen as an intersection of different cultural, social, historical, and economic factors which play out differently for different people. More complicated than just looking at land relations, vulnerability to climate change and environmental hazards is based on these factors that are already imbedded in that landscape and which all interact with one another to produce this differential vulnerability that we see within societies and across cultures. Because of these differences and added societal inequalities that exist, every person's vulnerabilities to disaster is different and unique (Kimberley, et al, 2019).

Incorporating the concept of resilience is a way to better gauge the perceived social and environmental vulnerability of a community and their capabilities of recovering from such

change in a socially equitable manner. Research has been done in the past into the understanding of ecological resilience of ecosystems as well as social resilience of marginalized people and risk management. Taking a political ecology framework in this paper, I aim to integrate those two forms of resilience to form socio-ecological resilience, which can be defined as “the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure and feedbacks, and therefore identity, that is, the capacity to change in order to maintain the same identity” (Folke et al., 2010). Resilience can be understood through the lens of ‘adaptive capacity’: “the social and technical skills and strategies of individuals and groups that are directed towards responding to environmental and socioeconomic changes” (Smit and Wandel, 2006). Using this concept allows scholars to better understand how communities will be able to bounce back from socio-ecological disruption and how these communities will be able to retain their identity in the face of change (Folke et al., 2010).

Neil Adger (2006) makes the connection between vulnerability and resilience by looking into traditional research on vulnerability to environmental change and the challenges for present vulnerability research to integrate into their analysis the concepts of resilience as well as adaptation. Adger's paper reviews existing analytical approaches to vulnerability to environmental change in order to propose connections between research on vulnerability and on resilience of socio-ecological systems. The challenges for modern vulnerability research are to develop diverse and reliable measures to include resilience and adaptation into their analysis and to incorporate governance research into their analysis of the mechanisms that promote this adaptation and resilience. Adger asserts that it is possible to combine resilience and vulnerability as the emerging insights into the resilience of socio-ecological systems can complement and

significantly add to research on the challenges faced by human-environment interactions under stresses caused by global environmental and social change. Evolving understanding into the vulnerability of social-ecological systems show that vulnerability is influenced by the build-up or erosion of social-ecological resilience (Adger, 2006).

Although the term resilience is now popular in climate change discourse, there are arguments against the use of the term resilience and the implications rooted within it. As Ranganathan and Bratman (2019) argue, the meaning of resilience often differs based on the language used to define it. In the natural sciences, the term resilience means the “ability of social systems to weather adversity; to bounce back from unforeseen disruptions or shocks” (Ranganathan and Bratman, 2019). This language, however, suggests that resilience is the capability to return to the previous state before the disruption. Understanding resilience in this way can be problematic when used in an environmental justice framework because it does not address the root problems and structural inequalities that have caused them to need to be resilient in the first place. Ranganathan and Bratman address this by asking how abolitionism might translate to environmental and climate justice and uses black radical thought and feminist theory to look at this new form of abolitionist climate justice, which seeks to change the system rather than restore it (Ranganathan and Bratman, 2019). Because federal disaster recovery efforts typically seek to restore communities back to their pre-disaster normal, these efforts often also work to restore the racial inequality and the legacy of American racism.

The authors argue that the use of resilience language tends to normalize the increase of environmental and socio-economic threats and assumes the endless capacity of the groups affected to cope, while simultaneously promoting neoliberal doctrines that benefit corporate executives who profit from federal resilience-related contracts. Instead, Ranganathan and

Bratman argue for the need to frame resilience in a different way, through a climate justice and abolitionist framework that addresses racism and oppression as core components of resilience language and practice. Resilience and vulnerability, through this framework, are not limited to technical solutions like levees and floodplain maps but could also include addressing other factors that are historically influenced by race, like the housing crisis and food security (Ranganathan and Bratman, 2019). Compared to the view of vulnerability proposed by Malm and Esmailian, the abolitionist framework proposed by Ranganathan and Bratman is more intersectional and includes factors beyond class and economic status to address resilience and vulnerability to natural disasters and climate change. In the aftermath of a disaster, community resilience can also lead to increased communication and preparation for potential future events (Cutter et al., 2013, 2010; J. Liu, 2010; Posey, 2009; Tobin, 1999).

Finally, post-disaster theory compliments my research by looking at what happens after the disaster takes place. Post-disaster theory can most applicably be applied to the historic Hurricane Katrina in New Orleans in 2005. After conducting a literature review of relevant material related to Hurricane Katrina and vulnerability, it was clear that the effects of these disasters do not only last for the duration of the natural disaster but last long after it has ended. The literature created through the research of past disasters, especially Hurricane Katrina, informs me of how natural disasters could play out in my case study. According to this literature, historical disparities in the socio-demographic landscape of New Orleans shaped the vulnerability of locals and their responses to Hurricane Katrina and its aftermath. These disparities were based in race, class, gender and have created differential disparities within social classes in New Orleans. Incorporating post-disaster theory, disasters can be understood as not just one event, but multiple events including what happens in the wake of the disaster. A

person's social and economic class is not only affecting their vulnerability and susceptibility to disasters and the effects of climate change, but also their ability to recover after the fact (Bullard and Wright, 2009).

Throughout my analysis I will be analyzing the built infrastructure as a tool to be better understand the landscape, including where increased infrastructure and power is concentrated within the city. Although often thought of as banal and unspectacular, infrastructure does not only help point towards environmental injustice, but also reveals how infrastructures operate with multiple temporalities that distribute life and harm. As they accumulate and distribute resources over time, infrastructures hold the past within them. Analyzing this infrastructure helps us recognize how past histories of injustice are remade and how they present themselves in the present. Susan Leigh Star emphasizes the importance of studying the dull realities of infrastructure: "Study a city and neglect its sewers and power supplies, and you miss essential aspects of distributional justice and planning power" (1999).

Based on my literature reviews and research, I decided to use the index produced by Hazards and Vulnerability Research Institute at the University of South Carolina. According to this index, race, age, and income account for the largest percent changes in social vulnerability to environmental hazards among communities in the United States (Social Vulnerability Index). Gauging someone's vulnerability to a specific hazard is a very complex and difficult thing to do, and gauging whole social groups vulnerability is even more difficult. To simplify my research, vulnerability is a combination of both social and physical factors. In the case of my analysis, the social factors going into vulnerability that I am looking at are age, race, and income. The physical factors I focused on were geographic location, specifically focusing on low-lying areas, and areas within close proximity to the coast and bodies of water. Additionally, resilience is an

important measure for social vulnerability because it allows us to understand what is required to recover from a disaster. I acknowledge that there are other factors that can affect one's vulnerability, including disabilities and social support, but this study did not have the time or capacity to include all other factors in the analysis.

Methodology

In order to gather the information and data that I needed to answer the question I was researching, I needed to gain a more comprehensive understanding of the landscape that I was working with and the interactions between people and place in the City of Santa Cruz. I wanted to collect geographic data in Santa Cruz and collect ethnographic data through observations and interviews. By looking at demographic information, geographic maps, interviews, physical observations, and by reading the current city Climate Adaptation Plan, I was able to gain this understanding to create social and physical maps of the Santa Cruz landscape that highlight vulnerability.

I began my research by looking into the demographics of the City of Santa Cruz as a whole as well as of specific parts of the city individually. I conducted this research by looking at online sources and census information that is available to the public. I was able to use maps to visualize the social layout of the city and how demographics changed from census area to census area within the city. I was then able to overlay these maps onto one another to gain a more comprehensive understanding of the general demographics of these different census tracts. When collecting this data, I focused specifically on factors such as age, average income, and ethnicity. In addition to this, I used online resources and FEMA maps to identify the parts of the city that

are geographically most vulnerable to flooding caused by sea level rise and increased extreme weather due to their proximity to the coast and other bodies of water.

I then focused on gathering ethnographic data by conducting a socio-spatial analysis of the landscape by physically walking around, making observations of the landscape and the people that I saw and then conducting interviews. During my studies I have come to understand how infrastructure can often be a useful tool in observing the underlying inequalities and disparities between the people who live there. Because of this, I focused on infrastructure when observing the landscape. By looking at infrastructure, I was able to see the different ways that social inequality has manifested itself within the landscape. While gaining a better understanding of the physical layout of the city, I also wanted to gain a better understanding of who lived there and how they were feeling impacted and vulnerable to potential climate disasters. Due to limited time and resources, I decided to conduct 'key informant interviewing' for my research by looking at one or two key people that would be capable of giving me relevant and accurate information about the community. The interviews I conducted were semi-structured with general prompts for the interviewees but no restrictions on what they preferred to elaborate on as the discussion went on (Bernard, 1995). By doing my interviews this way I will be able to get the information I need while letting the interviewee focus on what is most relevant or important to them.

Finally, I read through the existing City of Santa Cruz Climate Adaption Plan 2018-2023 to see what policies and measures the city was taking to address vulnerability to natural disaster in the city. I then compared this with my own assessment of vulnerability to these disasters. I wanted to pay close attention to how the city looks at vulnerability within the city and if they consider social vulnerability in their analysis at all. I also wanted to see if the city was aware of

the differential levels of vulnerability present and the root causes of these differences. To gain a better understanding of the cities policies and process of making the Climate Adaption Plan, I talk with the Climate Manager for the City of Santa Cruz who manages and is in charge of the cities response and preparation to the effects of climate change.

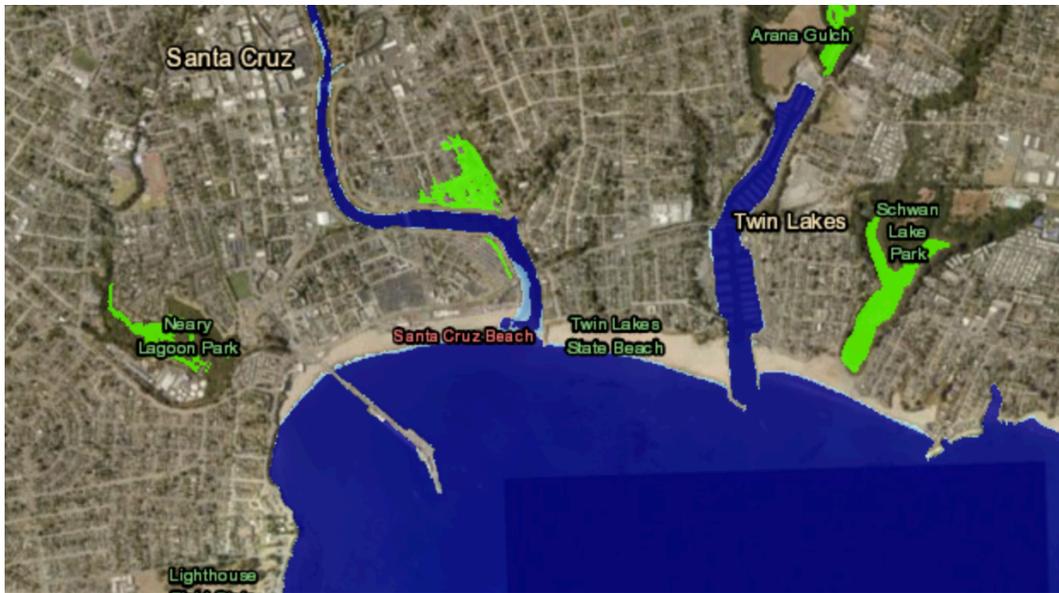
Results and Data

Demographic and Geographic Data

Perhaps the most important aspect of my research is understanding what parts of the city will be experiencing the most vulnerability, and who lives in those areas. As you can see on Maps 1 and 2, the most geographically vulnerable locations are the ones that are at most risk of sea-level rise and potential floods. Map 1 shows the projected regional three-foot sea level rise while Map 2 shows the areas that are most vulnerable to flooding due to increased water flow in the landscape. Together, Maps 1 and 2 display the geographical and physically vulnerable locations in the city caused by sea level rise and flooding. In addition to this, maps 3-5 show the social, economic, and racial layout of the city in an attempt to gain a better understanding of who is living in these geographically vulnerable locations identified in Maps 1 and 2. Map 3 shows the racial layout (white/non-white) of the Santa Cruz coastal landscape with the darker colored portions of the map representing primarily non-white communities, Map 4 shows the median household income in the same Santa Cruz landscape with the darker regions representing higher income and likely overall wealth, and Map 5 shows the average age of residents within these designated census tracts with the darker regions representing primarily older residents.

Based on my demographic research of the landscape that I conducted, the neighborhood that is most vulnerable to the effects of sea level rise and increased flooding is the Beach Flats

community. The Beach Flats community is a small section of the city squished between the Santa Cruz boardwalk and the San Lorenzo River near the coast. This location is increasingly susceptible to floods caused by increased water flow to the San Lorenzo River and encroaching sea-level rise (FEMA Flood Map). According to the census data I collected, this community around the Beach Flats is 70-90% Hispanic, aged 32 or less with a per capita income of \$18,000 or less. Additionally, 25% or more of the population in this neighborhood is living in poverty (US Census, 2010). To compare, based on my data the neighborhood that is least vulnerable to sea level rise and increased flooding is the West Cliff Drive communities. According to the data I collected, this community is 85-95% white, older than 32, and living with a per capita income of \$40,000 or more (US Census, 2010). To generalize based on this data alone, young, poor, people of color (primarily Hispanic) are facing the most geographical vulnerabilities to the effects of climate change, primarily sea level rise and increased flooding events, while white, older, and wealthier people are facing the least amount of geographical vulnerability. It is important to note also that although these two neighborhoods are the most different in perceived vulnerability to natural disasters, they are less than a mile from one another and approximately a 15-minute walk between.



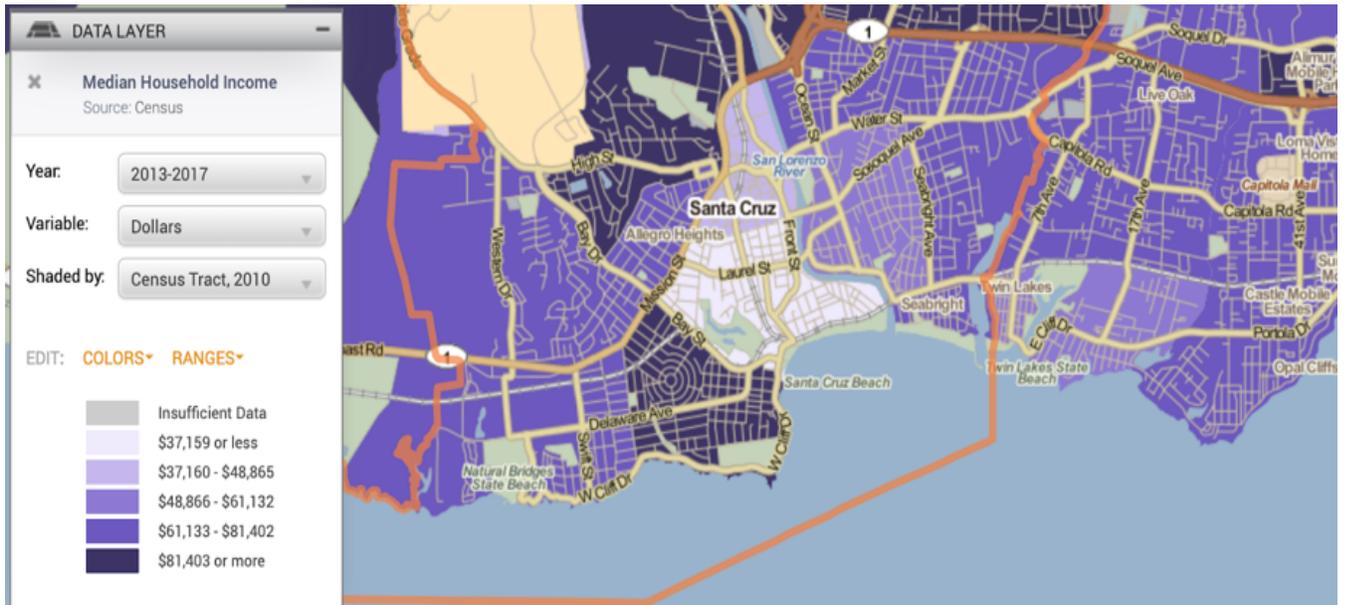
Map 1. Physical Map of projected sea-level rise
Source: NOAA Sea Level Rise Visualizer



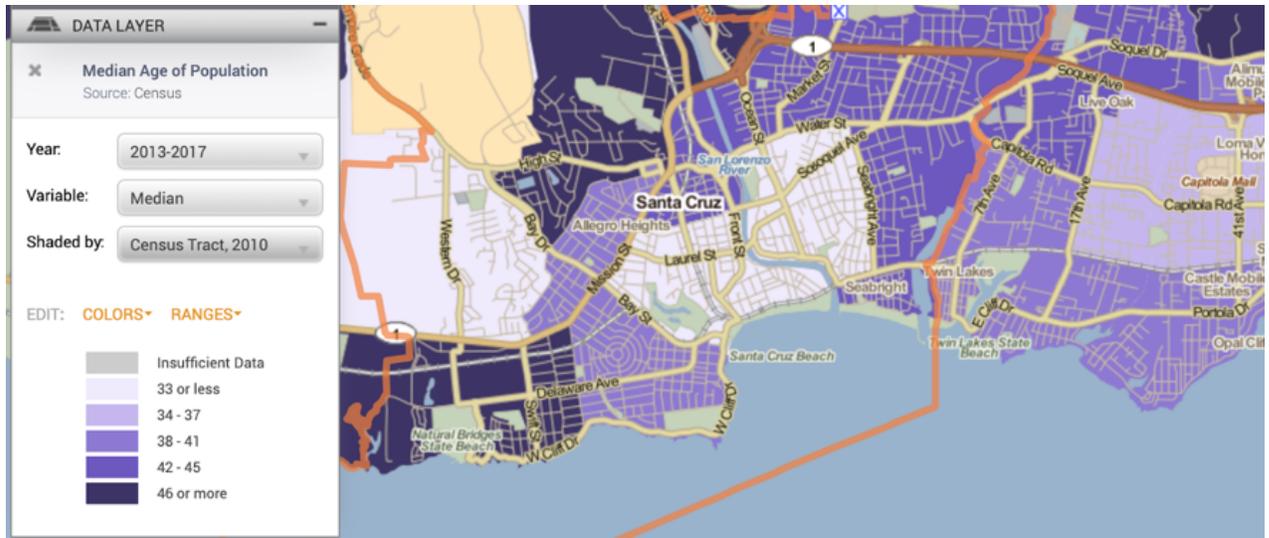
Map 2. Physical Map of flood at-risk areas
Source: FEMA Flood Maps



Map 3. Social Map showing Percent Non-White Population in Santa Cruz
Source: Polycymaps.com



Map 4. Social Map showing Median Household Income in Santa Cruz
Source: Polycymaps.com



Map 5. Social Map showing Median Age in Santa Cruz
Source: Policymaps.com

Socio-Spatial Analysis

In addition to looking at maps, my physical observations of the landscape and infrastructure were able to provide me with a lot of insight into the physical vulnerabilities that some of these communities are facing first-hand. Based on my demographic and geographic data, I determined that it would be most helpful for my analysis if I spent my time observing the two communities in the landscape that are experiencing the most differential vulnerabilities based on my analysis, the Beach Flats neighborhood and West Cliff Drive neighborhood. While walking in these landscapes, I paid close attention to the people that I saw there as well as the general infrastructure of the area. While observing the West Cliff Drive neighborhood I was able to see beautiful mansions worth \$1,000,000 or more placed along a smoothly paved road. West Cliff Drive is located along a coastal cliff looking out onto the ocean and therefore is not at risk of immediate sea level rise, however they do experience risks posed by the erosion of the cliff. To adapt for this, the city had implemented coastal infrastructure and additional boulders along the coastline in these areas.

As I continued along the coast closer to the Santa Cruz Beach Boardwalk towards the Beach Flats neighborhood, I noticed a change in the road infrastructure with more cracks and uneven roads, changed building infrastructure, as well as fewer levels of coastal infrastructure to prevent against flooding (see Images 1-3). At such low elevation and at risk of being flooded by the San Lorenzo River as well, the Beach Flats neighborhood is much more vulnerable to flooding than the West Cliff neighborhood based just on geophysical factors. In addition to these geophysical factors, the Beach Flats neighborhood also suffers from lack of proper infrastructure in place to protect against natural disasters and flash floods. The houses located in the Beach Flats neighborhood were typically small with poor internal infrastructure and a significantly lower average real-estate value compared to the adjacent neighborhood of West Cliff Drive. In addition to looking at infrastructure I also was paying close attention to the people that I saw in these different neighborhoods. The Beach Flats neighborhood, located next to the popular Santa Cruz Beach Boardwalk, has significantly more people interacting with the landscape and infrastructure compared to the relatively quiet neighborhood of West Cliff Drive. The density of population in these two areas are vastly different with the majority of people and human traffic happening in the Beach Flats neighborhood compared to West Cliff Drive.





Images 1-3: Street View in Beach Flats Neighborhood

Interviews

To gain a better ethnographic understanding of this landscape and the people within it, I decided to conduct some interviews with key people within the landscape that would be able to inform me and provide to me the information that I needed. To do this, I reached out to the Beach Flats Community Garden to get in touch with a local community member or leader. I also reached out to the Climate Manager for the City of Santa Cruz and was able to coordinate a time to talk about the steps that the city is taking to address the differential vulnerability to the effects of climate change. Unfortunately, some of that ethnographic research had to be put on hold due to the COVID-19 worldwide viral pandemic in the Winter of 2020. Due to the physical distancing restrictions that have been implemented in California and across the country, my ability to conduct some of the ethnographic research that I had planned was not realistic.

I was able to interview Dr. Tiffany Wise-West remotely, the Climate Manager for the City of Santa Cruz who provided insight into how the Climate Adaption Plan was created and

how they used their social vulnerability index to help make their decisions about climate adaptation. During this phone interview, I learned that the Climate Adaption Plan was the first time that the city had taken major steps to focus on issues of equity as they apply to climate adaption. To showcase this focus on equity, the city included a social vulnerability index into their analysis of vulnerability to climate change in Santa Cruz. Since the Climate Adaption Plan, the city has taken on two other climate adaption projects, one focusing on the beaches that are most at risk and the other focusing on West Cliff Drive adaptation, both of which are more centered around equity. The variables that the city used to determine social vulnerability were taken from the same Social Vulnerability framework (SoVI) that my analysis is based on, however in their analysis they chose to omit the variable of race and ethnicity and instead use other variables that could act as proxies for race and ethnicity, like language. Dr. Wise-West told me that she often got comments from people asking why they didn't include race and ethnicity in their analysis. In response, she says that they made their decisions based on the information available to them and that some of the variables used in the SoVI analysis, like ethnicity, did not provide clear adaption path or action. Instead, they focused on other variables to act as proxies for these omitted variables.

Using the social maps collected on age, race, and household income as well as these physical and geographic maps of the Santa Cruz coastal landscape, I was able to come to a better understanding of which communities are at most risk to sea level risk and flooding as well as what the demographic makeup of those communities are. Overall, my data shows that the communities that are the most geographically vulnerable to sea level rise and increased flooding are primarily made up of young, poor, people of color who are typically already facing existing social and structural inequalities within our society. The ethnographic research that I planned to

carry out in interviews as well as my own observations of the neighborhoods added to this assumption that was based off of geographical and demographic maps of the landscape.

Analysis of Results

Socio-Economic Production of Vulnerability in Santa Cruz

After reviewing my results, I wanted to understand the reasons behind why these different groups of people are more vulnerable to natural disaster and how that accumulated vulnerability came to be. To do this, I needed to look at the root causes behind these vulnerabilities which are often born from historical, social, and economic injustices formed across the American landscape. Overall, it had become clear that the socio-economic production of vulnerability in Santa Cruz was more often than not dependent on existing social and economic structures in place, including age, class, and race. Through this research I came to understand how these people, who were already suffering from increased social vulnerability, were forced into the neighborhoods that were suffering from increased environmental vulnerability. When combined with the following analysis, my results are able to paint a picture of the Santa Cruz landscape in the face of climate change, which people will be most vulnerable, and why.

Age

Age can play an important variable in understanding vulnerability in this landscape for many different reasons. The ability to get up and leave the location on a disaster in an emergency is dependent on the physical strength and wellbeing of that person. If someone is dependent on others or is on bed rest then they will have a more difficult time reacting and responding to

potential emergencies and disasters that may arise. Elder care facilities have had more difficulty evacuating in the event of an emergency during past natural disasters in the United States (Benson and Aldrich, 2015). What I have found in my analysis of Santa Cruz, however, was that younger people were located in the more geographically vulnerable locations of the city. This could be explained because younger people may not have the wealth, knowledge, and resources that older people have been able to collect through their lifetime that made them more prepared for potential disasters. Additionally, it is possible that since younger people are more capable of evacuating in the event of an emergency, they are more comfortable living temporarily in a location that is more vulnerable, and therefore cheaper.

Class

My results show that people with lower economic status are located in places that are more environmentally vulnerable. As shown through in my literature review, economic class also plays a major role in determining one's vulnerability before, during, and after natural disasters and major flooding events. Before the disaster, one's ability to preemptively leave their homes before the disaster were to hit is often dependent on their access to transportation and ability to purchase car or plane ticket to leave the area. Additionally, the ability to take preemptive measures to protect yourself against potential disasters requires money and resources that are not available to everyone. After the disaster has taken place, the ability for these communities to recover from the damage that was potentially done is also dependent on their ability to access large amounts of cash savings in order to make the large-scale repairs to their property and general infrastructure that would be needed.

Historically, disaster recovery efforts frequently leave the survivors of the disaster without the assistance they need to find another residence and to build the resilience they need for the future. The lowest-income survivors are often unable to access the stable and affordable homes and resources they need to be able to recover from the disaster. This often leads survivors of these disasters back to their uninhabitable homes that were already destroyed. Federal mitigation and recovery efforts often can add to and perpetuate the history of underinvesting in and underserving these low-income communities and communities of color. This perpetuation ensures that these neighborhoods lack the basic infrastructure they need to survive another disaster. The existing disaster housing recovery framework that is used around the county often favors landowners and reinforces the racial and economic inequalities already present throughout the response and recovery stages (National Low-Income Housing Coalition, 2019).

Race

Perhaps most relevant to this study is the variable of race and its effect on the overall vulnerability and risk posed by climate change and increased flooding events. Although someone's race does not inherently make someone more susceptible to the physical effects of climate change, there are racial biases built into the landscape that have not been dismantled which often forces people into more vulnerable locations. Historically, race in America has played a major role in where people are placed within a city. Examples of this can be seen throughout American history as segregation of races became commonplace in the late 1800's. Eventually the effects of this segregation became engraved within the structure of the landscape and has led to the current practices of discrimination that we see to this day. These practices are generally referred to as "redlining", the systematic denial of various services to residents of

specific, often racially associated, neighborhoods or communities, either directly or through the selective raising of prices (Gross, 2017). This process often deems certain social classes and their neighborhoods as undesirable therefore lowering their property value and making it more difficult for them to leave and move somewhere else (Pulido, 2010). These redlining practices are engraved into the landscape of Santa Cruz, and most cities in the United States, and still affect these local populations and communities today. Because of this, people of color are often indirectly forced into undesirable parts of the landscape, which in this case would be parts of the landscape that are especially threatened by the effects of environmental change and disaster.

Additionally, as was shown through my data, the neighborhoods that are most vulnerable, the Beach Flats, consist of primarily Hispanic residents who often speak Spanish. The City of Santa Cruz sends out emergency notifications and alerts to residents before and during major storms and natural disasters. As of 2015, 33% of the population in Santa Cruz County identifies as Hispanic, with only 68% of the population speaking only English. (U.S. Census Bureau, Santa Cruz County Quick Facts). In the past, the City of Santa Cruz emergency notifications were not given in Spanish as well and, in turn, were making Hispanic communities more vulnerable (Fox, 2018). These types of cultural differences create opportunities for discrimination between different types of people that creates the accumulated vulnerability that are experienced today.

Infrastructure

One variable that I was able to observe visually throughout the landscape was the existing infrastructure, both public and private, and the differences in infrastructure between my two study sites. Infrastructure and housing are a key component to adapting, mitigating, and reducing the impacts of environmental change and natural disasters, especially flooding events. Bringing

together other variables of class and race, the level of public infrastructure you experience is very dependent on your economic status and the value of the land and property that you are living. As previously described, race can play a role in determining where people are placed and the amount of infrastructure they have access to. Although usually overlooked as irrelevant and banal, infrastructure is an excellent way to understand social and economic structures and differences within a landscape (Star, 1999). As I observed throughout my spatial analysis of the landscape, the Beach Flats neighborhood and West Cliff Drive show different levels of coastal and fundamental infrastructure that could protect against the effects of climate change.

When looking at the damages and consequences of the effects of sea-level rise, the City of Santa Cruz basis its prioritizations on protecting, maintaining, and updating existing infrastructure based on the estimated monetary costs and necessity associated with the infrastructure. This means the city is potentially prioritizing the areas with more expensive or essential properties when it comes to protection against environmental hazards. Examples of this coastal infrastructure in Santa Cruz are riprap, man placed rocks and boulders used to armor shorelines to protect against erosion, and sea walls, a wall erected to prevent the sea from moving onto land. In addition to these coastal measures, the downtown and Beach Flats neighborhoods of Santa Cruz are also at risk of flooding due to the San Lorenzo River which runs through the heart of the city. Currently, residents are protected by levees constructed by the Army Corp of Engineers in 1959, but these levees and other forms of anti-flooding infrastructure like water pumps could be inadequate in the face of climate change and increased extreme weather events (Griggs, 1982).

The City of Santa Cruz's Climate Adaption plan shows a very comprehensive understanding of climate vulnerability within the County of Santa Cruz as well as what the city is

doing to address what they see as main adaptation priorities for the city and its residents. Within their analysis of vulnerability, they include a social vulnerability analysis to complement their understandings of climate change vulnerability, similarly to what I have done in this paper. Although the city includes these social vulnerability indexes within their analysis, their primary objectives and goals for this plan focus mainly on economic and environmental sustainability and recovery and do not address directly the differences in vulnerability that are being felt in the city, and why some people are experiencing more vulnerability compared to others. Although the current Climate Adaptation Plan identifies which groups of people are most vulnerable and where they are located, I argue they fail to take substantive action on this issue of equity within their adaptation policies and mitigation measures.

There have been policies put into place to help lessen the social vulnerabilities of certain groups in the city, such as the adoption of including Spanish language emergency notifications for areas with a primarily Hispanic and Spanish speaking population. I argue, however, that in order to truly address these issues and social vulnerabilities, more drastic steps should be taken to dismantle the underlying structures and variables that are forcing these populations into these homes in the first place. Rather than simply putting a band-aid on the issue of social vulnerability by broadcasting in Spanish, the city should take measures to address underlying issues like the ongoing housing crisis in Santa Cruz as a form of climate adaptation. That is not to say adaptation measures like this are not helpful, they just do not address the root causes of these vulnerabilities.

As climate change continues to increase the frequency and magnitude of sea level rise and coastal flooding, the social and economic inequalities present within the landscape will begin to show themselves, with more low-income people of color being seriously affected by these environmental hazards on average. We know the places in the city that are most geographically

vulnerable, and we know who is historically located in these areas and the effects that a major flood can have. The 1955 Flood of Santa Cruz wiped away a large portion of the downtown, especially the local Chinatown section of the city which was placed in one of the most vulnerable areas. Knowing this history, the City of Santa Cruz should look to prevent similar trends from taking place in the future.

Discussion

Connection to Existing Literature

After doing my analysis I made the connection between my observations and the literature I had read. My research has found that vulnerability is based on both geographic but also social and economic structures and that there is differential vulnerability among the Santa Cruz population to natural disasters. These vulnerabilities are likely to increase as climate change continues, and are often tied to existing and historical structures within the landscape. This case study of vulnerability in Santa Cruz shares similarities with case studies done on other landscapes around the world, from Egypt to New Orleans, and the impacts that natural disasters and climate change have brought.

Through my analysis of different variables, I have come to the conclusion that in order to understand the risks and prepare for the potential effects of natural disasters it is necessary to understand both the environmental hazards caused by the disaster but also the social and economic structures that put the people who are the most socially vulnerable into the places that are most physically vulnerable, something that is echoed throughout modern vulnerability research. Vulnerability in the landscape of Santa Cruz impacts every person differently based on who they are, which creates the differential vulnerability that was also observed through the case

studies of Hurricane Katrina and its differential impacts on the residents of New Orleans. In both cases, the socially vulnerable residents were forced into the areas of the city that were most vulnerable to flooding by amplifying the already existing social and economic inequalities present within the landscape. My research has also shown that one way of identifying the differential vulnerability within a community to the effects of a natural disaster is by looking at the variables of geographic location, age, economic class, and race. These variables are used commonly to measure social and environmental vulnerability in existing literature to highlight the differential vulnerability that may be present within a community. Through these variables, the vulnerability landscape of Santa Cruz can be better understood.

As discussed in the piece by Malm and Esmailian (2013), in the Northern Nile Delta the least vulnerable community and the most vulnerable community are both located in the frontline communities. In the case of the Mubarak, these frontline communities consist of the wealthy farmers who have the resources to cope and adapt to these changes as well as poor farmers who have nowhere else to go and have been forced into these places because, without the proper resources, they are uninhabitable. I was able to draw comparisons from my research to the research presented in this paper as, in Santa Cruz as well, the frontline communities consist of the wealthy who are able to afford proper coastal infrastructure and who are able to easily leave the area and the poor who are forced into vulnerable locations because they have nowhere else that they can go.

Contributions to Existing Literature

My research into the landscape of Santa Cruz contributes to the existing literature on natural disasters and the differential effects of those disasters throughout the community

affected. In my research, I add the continued focus on climate change and the implications that this research has on the future of coastal societies in the face of climate change. Although there is yet to be a climate disaster comparable to Hurricane Katrina in Santa Cruz, this research shows that it is likely that these events will eventually happen here and that they could have detrimental effects to some people of Santa Cruz, partially based on their ethnic identity and economic resources. Additionally, my research focuses on the historical context and roots behind the vulnerability that is addressed throughout the literature rather than on the fact that there is differential vulnerability alone. Unlike the existing social vulnerability index for the City of Santa Cruz Climate Adaption Plan, my analysis of socio-ecological vulnerability includes race and ethnicity as a component of what might add to increased vulnerability given the existing social and political structures in place. By highlighting this specific variable in my analysis and its role in shaping vulnerability, I am adding to the existing knowledge of how vulnerability is produced in Santa Cruz in the face of climate change and increased social change.

Considerations

This paper is meant to provide an understanding of the differential vulnerability to sea-level rise and flooding in Santa Cruz and to use that information to understand how the city can implement better climate adaption policies. I want to recognize and communicate to my readers that one should be careful when generalizing entire social groups as vulnerable based on subjective determinants as they can often lead to discrimination and unfair generalizations on the actual people apart of those social groups. My results are grossly generalized and it is important to reiterate that although my research shows that young, poor, Hispanic residents are the most vulnerable to climate disasters in Santa Cruz, this does not mean that all young, Hispanic, or

poor people are innately more vulnerable. To gain a greater understanding of vulnerability these communities should be looked at on a person by person basis. I want to caution against labelling certain areas and communities as vulnerable and more vulnerable than others because that may not necessarily be true, and might be a subjective term used to describe a group of people.

Continued Research

Given more time and additional resources, I would have liked to do a more comprehensive and accurate statistical analysis of the population of Santa Cruz through a person-to-person analysis of each household in the two neighborhoods identified in my study site, Beach Flats and West Cliff Drive. My results would be more accurate if I were to conduct interviews in person with multiple residents across the landscape to better gauge their personal vulnerability to possible natural disasters. In this paper I am focusing on sea-level rise and increased flooding but there are additional threats faced by Santa Cruz caused by climate change which I could be looking into as well, like vulnerability to forest fires or possible heat waves. Additionally, I would like to conduct more research into measures and policies the City of Santa Cruz can take to promote socially equitable climate adaption and mitigation within the city. Right now, the city's most vulnerable residents are located in some of the most vulnerable locations to natural disasters and, given more time, this paper could address and list some recommendation for the city to enact in order to address these differences.

Conclusion

Someone's vulnerability to the effects of climate change is not only a factor of their geographic location, but is also influenced and determined by their social status and their

property relations within the society. Because of this, socially vulnerable communities are usually placed in geographically vulnerable locations. As climate change continues to change our daily lives and disrupt the global ecosystem it will continue to put pressure on the already existing social structures as well as the social inequalities that are already present within our societies and social structures. Climate change will inevitably exacerbate and make more obvious the social inequalities present within our societies and engraved into the landscapes. Similar to past natural disaster that have been experienced in the United States, like Hurricane Katrina in New Orleans, I wanted to know if future climate disasters, which are likely to increase, will have similar unequal effects on the poor and people of color who are already facing preexisting inequalities within their landscape.

My evidence and analysis have shown that there is differential vulnerability to the effects of climate change along the Santa Cruz coast and that we should be taking action now to be able to adapt and cope with these changes in a socially equitable way. In order to address these differential vulnerabilities, the City of Santa Cruz can take multiple different policy approaches to reduce these disparities. For example, the city could begin including more comprehensive social vulnerability analysis in their Climate Action Plan so that they are able to make informed policies based on all of the information they will have access too. The current analysis done by the city omits race and ethnicity as a factor contributing to social vulnerability which I believe is an important factor to consider in our analysis. As Pulido (2010) says in their article: “a normative conceptualization of racism informs the research.” By addressing these underlying inequalities within the society, the city will be able to make the most appropriate and effective climate adaption policies. I would also suggest that the city begin to prioritize their adaptation policies and projects based on population density of the affected areas rather than based on the

monetary loss of the physical damage done to the affected infrastructure and buildings. Disaster recovery in the city should not just focus on the property owners but should also benefit the residents that lived there.

I would encourage the city of Santa Cruz, and all other cities around the USA, to not shy away from the history of the landscape that they are on and acknowledge the existing inequalities present in an attempt to dismantle them. Acknowledging and facing this head on would allow the city to better understand how vulnerability is produced and how they can go about mitigating the root causes of this vulnerability. Ultimately, for the city to be able to make comprehensive adaption and mitigation measures to protect against climate change, they will need to focus on the societal factors that are driving the underlying vulnerabilities throughout the city rather than just attempting to make a short-term solution to the problem. Through understanding past disasters, like Hurricanes and the 1955 Santa Cruz flood, we will be able to better understand how to adapt to our changing environment in a socially equitable way.

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